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BEHAVIOR OF *OSMIA* (*NOTHOSMIA*) *MARGINATA* MICHENER IN THE NEST (HYMENOPTERA: MEGACHILIDAE)

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Osmia (*Nothosmia*) *marginata* Michener is a relatively uncommon, megachilid bee restricted to the southwestern deserts of Arizona, California, Nevada and Utah (Parker and Bohart, 1966; Parker and Tepedino, in prep.). Individuals have been recorded visiting a variety of plants in the spring and the species appears to be polylectic (Hurd, 1979). Like other members of the subgenus *Nothosmia, O. marginata* uses pre-existing holes in which to nest. The species also nests readily in artificial domiciles (Parker and Bohart, 1966), and we took advantage of this behavior to observe the within-nest activities of adult females in the greenhouse. Specifically we report on preparation of the cell, provisioning, egg-laying and construction of the cell partition.

Methods

Individuals of *O. marginata* were obtained from elderberry trap-nests that had been set out near Joshua Tree National Monument, Riverside County, California, the previous year. Upon eclosion in late April, males and females were released into a greenhouse (6 × 8 m) that contained species of *Coreopis, Papaver, Borago* and *Phacelia* as pollen and nectar sources and *Oenothera* as a source of leaf material. The greenhouse also contained a 1 × 1 × 2 m observation box made of plywood with holes drilled in one wall. Elderberry (*Sambucus*) twigs were inserted into these holes as nesting material. A 6 mm diameter hole was drilled in each twig to a depth of about 23 cm. A transverse cut was made halfway through each twig 20–30 mm below the entrance hole and then continued lengthwise to the end of the twig (Fig. 1). This section was then removed to expose the bore of the hole and replaced with a glass plate which was taped to the twig. The behavior of bees using these nests could be clearly observed and was recorded with a digital clock and tape recorder.

Results

Detailed observations on two nesting females were conducted from 1015–1520 hrs on 4 June about five weeks after the bees had been released. In the

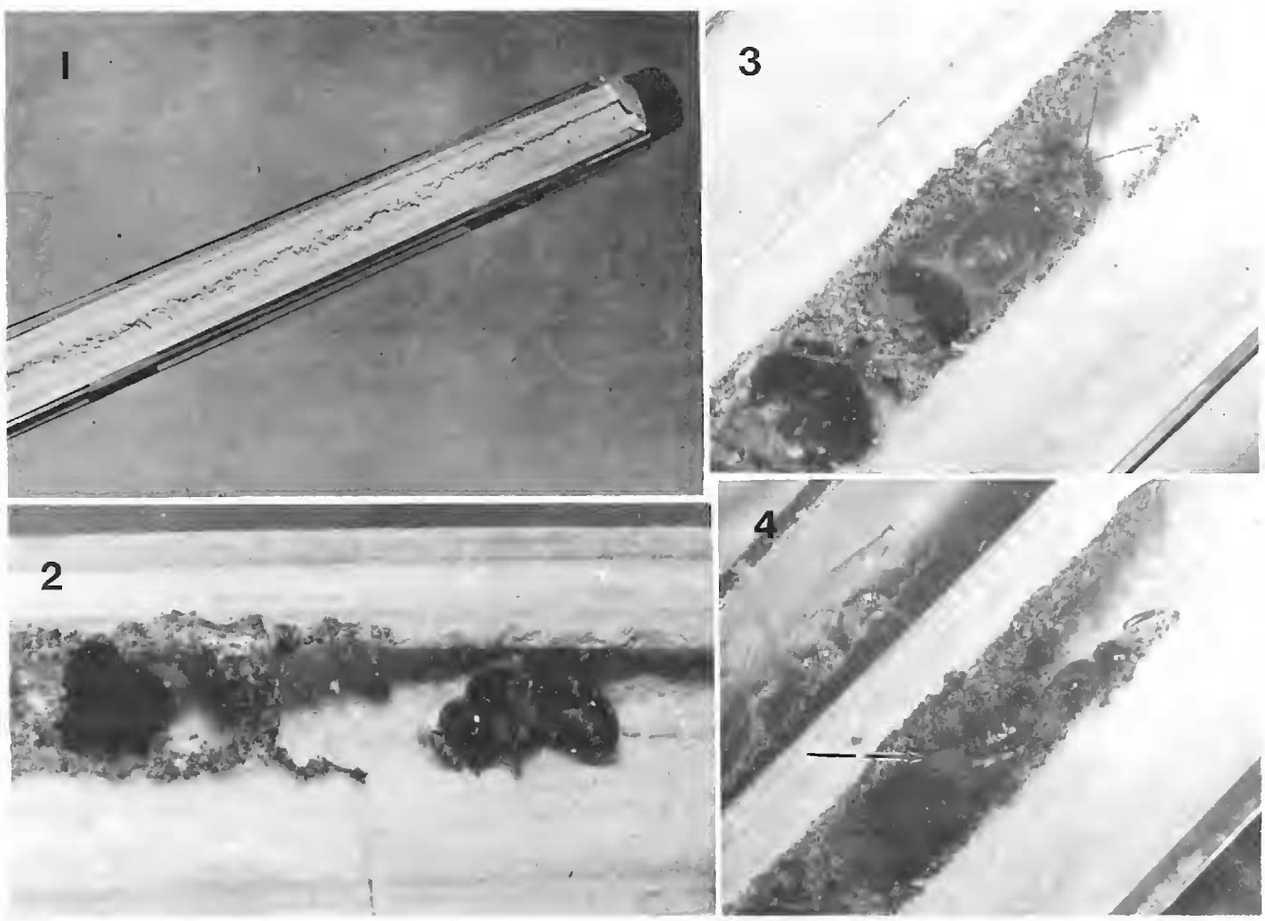
observed nests, Bee 1 was provisioning her fifth cell and Bee 2 her second cell. The behavior of nesting females is described in chronological sequence, from preparation of the new cell to its completion.

Preparation of the new cell.—Complete preparation of a new cell was observed for both bees, and was the same except for one important detail. Upon completion of the partition of the cell below, Bee 2 appeared to roughly equate the length of the cell to be constructed with the length of her body. Facing outward, and with the tip of the abdomen close to the previously finished partition, she applied masticated leaf material to the cell walls with her mandibles and forelegs to form a raised rim or threshold around the entire circumference of the hole. This threshold later served as the foundation of the partition that sealed the cell. Bee 1 did not build a threshold at this time but proceeded directly to the next phase in which the walls of the new cell were partially lined with leaf pulp. The females made numerous trips for leaf material and always entered the nest head-first carrying a ball of leaf pulp in the mandibles. Before application to the walls, the ball was transferred to the forelegs and chewed and flattened with the mandibles. Perhaps a salivary secretion was introduced as well. This pulp was then applied to the walls with mandibles and forelegs, beginning at the posterior end of the cell. After each deposition of leaf pulp, she applied a salivary secretion to both leaf material and bare pithy walls with her mouthparts. Both bees applied their mouthparts to areas of the cell wall that were quite distant from the area of leaf application. The secretion was clear and could not be discerned when it dried (Fig. 2). Neither female applied leaf material to the glass wall but did fill in spaces between glass and twig with leaf pulp.

When lining and shellacking of the cell walls was complete, Bee 2 immediately began to provision the cell since she had already constructed her threshold. In contrast, Bee 1 constructed the threshold after lining the cell and before provisioning. Her threshold was also more substantial and was constructed differently from that of Bee 2. The partial partition in the nest of Bee 2 was made by assuming a C-shape and pressing the abdomen against the leaf ball while it was held against the cell wall and worked by mandibles and forelegs into a flattened disc.

Twenty-four leaf collecting trips (2 hr 38 min) were required by Bee 1 to complete the cell preparation process. Average duration of time periods spent in the nest was 3 min 18 sec ± 1 min 32 sec (range 40 sec–7 min). Leaf-collecting trips averaged 3 min 36 sec ± 3 min 22 sec (range 1 min 15 sec–17 min 35 sec).

Nectar and pollen deposition.—Females collected both nectar and pollen on almost all foraging trips. A returning female entered the nest head first and disgorged a nectar droplet upon the provision; this droplet was used to wet the dry pollen deposited on the previous trip and to work it into the provision with mandibles and forelegs. She then backed out of the nest,



Figs. 1–4. Fig. 1. Experimental nest constructed from an elderberry stem and fitted with a glass plate. Fig. 2. A female *Osmia marginata* applying the salivary secretion to bare cell walls. The closing partition, pollen ball and egg in the previous cell are clearly visible. Fig. 3. A female *Osmia marginata* scraping pollen from the ventral abdomen onto the provision. Note the light-colored layer of unincorporated pollen on the provision. Fig. 4. A female in the act of laying the egg (arrow).

turned around and re-entered, abdomen first, and continued backwards to the provision where the pollen in the abdominal scopa was kicked onto the provision with the hind legs (Fig. 3). The unloading of pollen from the scopa took only a few seconds; while unloading pollen, the female maintained herself in rigid position supported by fore and mid legs with the antennae stretched out rigidly in front. As she left the nest after unloading, she continued to scrape the abdominal venter with the hind legs.

The completed provision typically measured 7–8 mm in length and 4 mm wide. The bottom and sides conformed to the shape of the cell. The provision was usually oval-shaped and somewhat moist or pasty.

A complete cell provisioning sequence was recorded for Bee 2. Twenty-six foraging trips were made to provision the cell completely over a period of slightly less than five hours. Nectar and pollen were collected on each trip. Average duration of foraging trips was 8 min 38 sec ± 2 min 58 sec (range 4 min 25 sec–13 min 25 sec). Little time was used to deposit nectar

and pollen in the nest; deposition time averaged only 57 sec ± 12 sec (range 25–85 sec). Except for two in-nest resting periods of roughly 5 and 17 minutes, this female worked constantly to complete provisioning.

Egg-laying.—Both bees were observed to lay eggs. Egg-laying in both cases immediately followed deposition of the final nectar and pollen load. Bee 1 followed the usual sequence of nectar and then pollen deposition and then turned around outside the nest and re-entered head first to incorporate the dry pollen into the provision. Bee 2, however, deviated from this sequence; she backed into the nest initially and deposited pollen first and then turned around outside, re-entered, and incorporated her nectar load while molding the provision. Bee 2 thus accomplished the final incorporation of pollen and nectar into the provision with one less trip to the outside to turn around than did Bee 1. This was the only time she exhibited this behavior.

In egg-laying the female backed down the burrow and worked the surface of the provision with the tip of the abdomen for a few seconds before the egg appeared. The female remained braced against the side walls for 90–120 sec with the abdomen curved slightly upward as the egg was extruded (Fig. 4). She then pulled herself away, and the egg remained with its posterior tip stuck in the provision. The egg was arched with the anterior end bent towards, but not touching, the provision. The female then moved away and groomed herself for a brief period.

Construction of the cell partition.—Closing of the cell partition began immediately after egg-laying. The working of leaf material was as described previously. The sides of the threshold were gradually thickened and extended and the opening covered by flattened leaf pulp. The entire process took about 30 min and required only seven leaf-foraging trips.

Discussion

Certain aspects of the nesting behavior of *Osmia marginata* agree with observations reported for other members of the subgenus *Nothosmia.* All species for which there is information utilize pre-existing burrows and construct cell partitions and closing plugs of leaf material (*O. cordata* Robertson: Rau, 1937; *O. albiventris* Cresson: Medler, 1967; *O. pumila* Cresson: Krombein, 1967; Medler, 1967). The provisions of all species also appear to be somewhat moist and liquid.

The use of leaf material to partially line the cell walls and the construction of a threshold appears variable among species. Medler (1967) reported that *O. albiventris* lined the walls with leaf paste in one nest but not another, and *O. cordata* (Rau, 1937) and *O. pumila* (Krombein, 1967; Medler, 1967) do not appear to line the walls at all. In the two *O. marginata* nests observed cells were only partially lined with leaf paste. In addition to *O. marginata* only *O. pumila* has been reported to construct a threshold (Krombein, 1967).

Other species of *Osmia* in other subgenera are also known to construct thresholds (Rust, 1974).

The application of a salivary secretion to bare cell walls has not been observed for any other species of *Osmia.* Indeed, only one other twig-nesting species in the family Megachilidae, *Chelostoma minutum* Crawford, is suspected to apply a salivary secretion to the bare cell wall (Stephen et al., 1969; P. F. Torchio, pers. commun.), although the use of saliva to make mortar nests has been reported for other megachilids (Eickwort, 1975). It is possible that other twig-nesting species in the family engage in similar behavior, but this can be confirmed only by direct observation because the secretion is visually undetectable after drying.

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